

4. 'Questions relating to the Formation of Coal-Seams, including a New Theory of them: suggested by Field and other Observations made during the past decade on both sides of the Atlantic.' By W. S. Gresley, Esq., F.G.S.

A number of new facts are described, and the bearing of these and of previously recorded facts upon the origin of coal is discussed, special reference being made to the Pittsburgh Coal. The Author lays stress on the stratification of coal, the sharp line of demarcation between coal and underclays, the character of the plants in the underclays and their asserted root-nature, the existence of partings in such seams as the Pittsburgh Coal, which partings sometimes contain *Anthracosia*, and really separate the coal into distinct seams. He describes the occurrence of 'rods' of vegetable origin whose exact nature is not known, which, with ferns, he suggests contributed largely to the formation of some coals. He maintains that the evidence points to the formation of coal on the floor of an expanse of water, by vegetable matter sinking down from floating 'islands' of vegetation, which may have been of very large size, and enumerates cases of such 'islands' or 'rafts' of vegetation which have been described as existing in modern times.

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#### MISCELLANEOUS.

*Researches on the Structure, Organization, and Classification of the Fossil Reptilia.*—Part IX. Section 4. *On the Gomphodontia.* By H. G. SEELEY, F.R.S.

THE Gomphodontia is a group of Anomodont reptiles characterized by Theriodont dentition, in which the molar teeth are expanded transversely, more or less tuberculate, and have the crowns worn down with use, as in ungulate and other mammals. The orbit of the eye is distinct from the zygomatic vacuity, which is conditioned as in the Cynodontia, there being a long narrow parietal crest dividing the temporal vacuities. There are two well-defined occipital condyles united at the base, in a way that is closely paralleled in some mammals. The occipital plate is triangular, as in mammals, with no perforation except the foramen magnum. A deep superior notch defines the occipital plate from the lateral external squamosal bar. The malar bone, which forms the larger part of the zygoma, behind the orbit has a slight descending process, which varies in development. The hard palate terminates transversely in the middle length of the molar teeth. There is a descending transverse palatine arch situate behind the orbits. The incisor teeth are small and pointed; the canine teeth may be inconspicuous, but are usually large, compressed, and serrated; the premolars are small, circular,

and usually tuberculate; the molars are usually single-rooted, in close-set series which diverge as they extend backward, with crowns which vary in form, but are commonly wider than long, and usually have the external and internal cusps more prominent than the other tubercles on the crown.

The group is based chiefly upon the genera *Gomphognathus*, known from skulls, a vertebra, and fragments of limb-bones; *Trirachodon*, known from skulls only; and *Microgomphodon*, in which the canine teeth are no larger than the incisors. The last genus appears to make known the more important parts of the skeleton.

These specimens, collected by the author at Lady Frere, by Dr. Kannemeyer near Burghersdorp, and by Mr. Alfred Brown near Aliwal North, are all from the Upper Karroo rocks on or about the horizon of the Coal Beds.

Of *Gomphognathus* there is a complete skull, with the lower jaw attached, about 9 inches long, a second skull which displays the palate, and a separate lower jaw in connexion with part of the back of the skull. These specimens show four incisor teeth in each premaxillary bone, with sharp lateral serrated borders. The mandibular canine is covered when the jaws are closed. The maxillary canine is a powerful tooth; its extremity is worn obliquely. There appear to be six premolar teeth, all contained in a length of half an inch. The maxillary teeth are packed in close succession, as in Rodents. There are nine molar teeth. In the middle, where they are largest, four occupy the length of one inch. The contour of the crowns of these molars is convex from front to back, as in many mammals; and in this genus they are all behind the hard palate. The external cusp is prominent, and a ridge descends inward and backward from it upon the large flattened ledge of the crown, which is worn almost level, as though there were a rodent-like horizontal movement of the lower jaw.

A lumbar vertebra, found in developing the back of the skull, may possibly belong to this genus.

With the skulls a right humerus was found, which is  $5\frac{1}{2}$  inches long. It shows the reptilian transverse elongation of the proximal articulation, combined with characters which are paralleled in the marsupial mammals and Carnivora.

The genus *Microgomphodon* is known in the first place from a skull  $2\frac{1}{2}$  inches long, shaped much as in *Galesaurus*, but distinguished by the comparatively large size of the front pair of mandibular incisors and the strong, conical, pointed character of the incisor teeth. The canine teeth are not differentiated from the incisors. The molars show in lateral aspect small blunt cones, but on their palatal aspect have flattened crowns with many small cusps. All the teeth have short roots. There are three incisors on each side in both the mandible and skull, one canine, and five molars.

There is ground for associating with this genus an imperfect skeleton, which, in addition to indicating ten early dorsal ribs and fourteen lower dorsal vertebrae and ribs in advance of the acetabu-

lum of the femur, shows the left humerus, portions of right and left scapulæ, portions of the coracoid, clavicle, interclavicle, the pelvic bones, all the bones of the hind limb, distal ends of ulna and radius, carpus, metacarpus, and five digits. With these a fragment of a skull is associated, which has the maxillary and mandibular teeth in contact, showing the animal to be Gomphodont; while so much as is preserved closely resembles the skull of *Microgomphodon*, and apparently the canine was not larger than the premolar. This skeleton demonstrates a close general resemblance of plan between the Gomphodontia and Cynodontia. The lower dorsal ribs have a transverse lozenge-shaped enlargement, which, however, is less developed than in *Cynognathus*. The pelvis is exposed on the ventral side. As in most, if not all, South-African Therapsuchia, it shows no indication of median division between the pubic bones, while the ischia retain their individuality.

The pubis articulated to a short tubercle on the ilium. The blade of the ilium is thin, but imperfectly exposed, and the ischia are shaped as in *Pliosaurus*, but the pubis does not closely resemble that of any reptile. The femur has the inferior internal trochanteric ridge only slightly developed. There is no neck defining the head of the bone from the shaft. The fibula is slender; no indication of a patella is preserved. Below the stout tibia the proximal row of the tarsus appears to consist of two bones—an inner astragalus with hemispherical proximal surface, and a narrow elongated bone which appears to be the calcaneum. There were three or four bones in the distal row of the tarsus, but only one is preserved. The digits are nearly parallel with each other, and the foot has a compact character like that of *Dicynodon*.

The scapulæ have the pre-scapula developed on the same plan as in *Cynognathus*, and the anterior margin of the bone reflected upward, so as to form the spine of the scapula. Terminating in the acromion. The two ends of the humerus are twisted at an angle of 45 degrees, and the bone is expanded as in many Saurischian reptiles. The carpus shows three bones in the proximal row, a large reniform carpal below the ulna, regarded as the pisiform bone; a comparatively small middle carpal is identified as the cuneiform bone. The third bone corresponds with the scapho-lunar of *Theriodesmus*; it is beneath the radius. There is no indication of any pre-pollex. There are four bones in the distal row of the carpus. There are five digits.

In the pelvis and the limb-bones this Anomodont type approximates to the Saurischia and Mammalia, just as the Ornithischia approximate to birds in the same parts of the skeleton.

*Trirachodon* is founded on four individuals which have the skull about 4 inches long. Like the other Gomphodont genera, this type has the dentary bone developed so as to occupy the length of the mandible, but the lower jaw is composite, the internal bones filling the space which in mammals is occupied by the meckelian cartilage. The postfrontal and prefrontal bones are well developed. The

species differ in the character of the teeth, especially in number and form of the premolars.

In one species from Aliwal North the molar teeth are transversely wide, ornamented with three transverse ridges, which terminate in a slight cusp both on the external and internal margins. There are not more than nine molars. The crown of the first premolar in one specimen is elongated from front to back, and shows a small coronet of rounded marginal cusps. In a species from Lady Frere the molar teeth are narrower and the premolar teeth more numerous, small, and circular in the broken sections.

Although these skulls are mammalian in aspect, and in some respects make new transitions towards mammals, in technical characters they retain a sufficient number of reptilian structures to permit no doubt that they are true reptiles. The mammalian resemblances in the skull being paralleled in the other parts of the skeleton, it may be affirmed that these fossils demonstrate a closer affinity between reptiles and mammals than had previously been evident.—*From the Proceedings of the Royal Society.* (Communicated by the Author.)

*The Transformation of the Aortic Arches in the Frog.*

By M. S. JOURDAIN.

In the course of investigations which for several years I have pursued upon frogs I have had occasion to study, by the aid of injections, the transformations undergone by the large vessels which spring from the bulb of the aorta at the time of transition from aquatic to aerial life. The results of my observations differ to such an extent from those which are recorded in the treatises on zootomy, that I have decided to present them to the Academy.

We know that in the tadpole of the frog the gills are four in number. The fourth, which is situated behind the rest, is considerably less developed than the other three.

In order to render my description more intelligible I shall have to modify the customary terminology in certain respects. I designate the great vessels, four in number, which carry the venous blood to the gills, *bulbar arches* (*crosses bulbaires*); *hypobranchial vessels* is the term that I apply to the portion subdivided from each of these arches which distributes itself to the gills, and by *epibranchial vessels* I mean the portion which brings back the aerated blood to the origin of the arteries which spring from these epibranchials. These arteries are, in the case of the first arch, the carotid linguals; in that of the second the aorta; in that of the third and fourth the cutaneous respiratory and the pulmonary.

The epibranchial vessels are united one to another on each side, at a short distance from the point of their emergence from the gill, by anastomotic branches, which have a longitudinal direction and are termed by me *connective branches* (*rameaux connectifs*).

Finally, it is important to note the presence of a short and wide anastomotic plexus, to which I shall apply the term *interbranchial*,